THE BENTHIC ENVIRONMENT OFF ORANGE COUNTY SANITATION DISTRICT'S OCEAN OUTFALL NO. 2 1/

by

Robert A. Hardy 2/

ABSTRACT

During May and June, 1972, Department biologists made an ecological investigation in the vicinity of the discharge from Orange County Sanitation District off the mouth of the Santa Ana River. The survey consisted of 30 random benthic grab stations positioned within one mile of the discharge site, 8 bottom trawls, and underwater observations of the new and old discharge pipes.

Abundance of polychaete worms in the grab samples indicates an area of enrichment adjacent to the diffuser in a northwest direction from the outfall.

Trawl data show fish species composition and abundance comparable to previous monitoring surveys except for a high density at one station about one mile northwest of the outfall.

Diving observations revealed normal biotic assemblages for this section of coast, however, previously noted growths of gorgonian corals at one station area were found in reduced numbers.

1/ Marine Resources Administrative Report No. 73-10, November 1973

2/ California State Fisheries Laboratory, Marine Resources Region, 350 Golden Shore, Long Beach, California 90802

INTRODUCTION

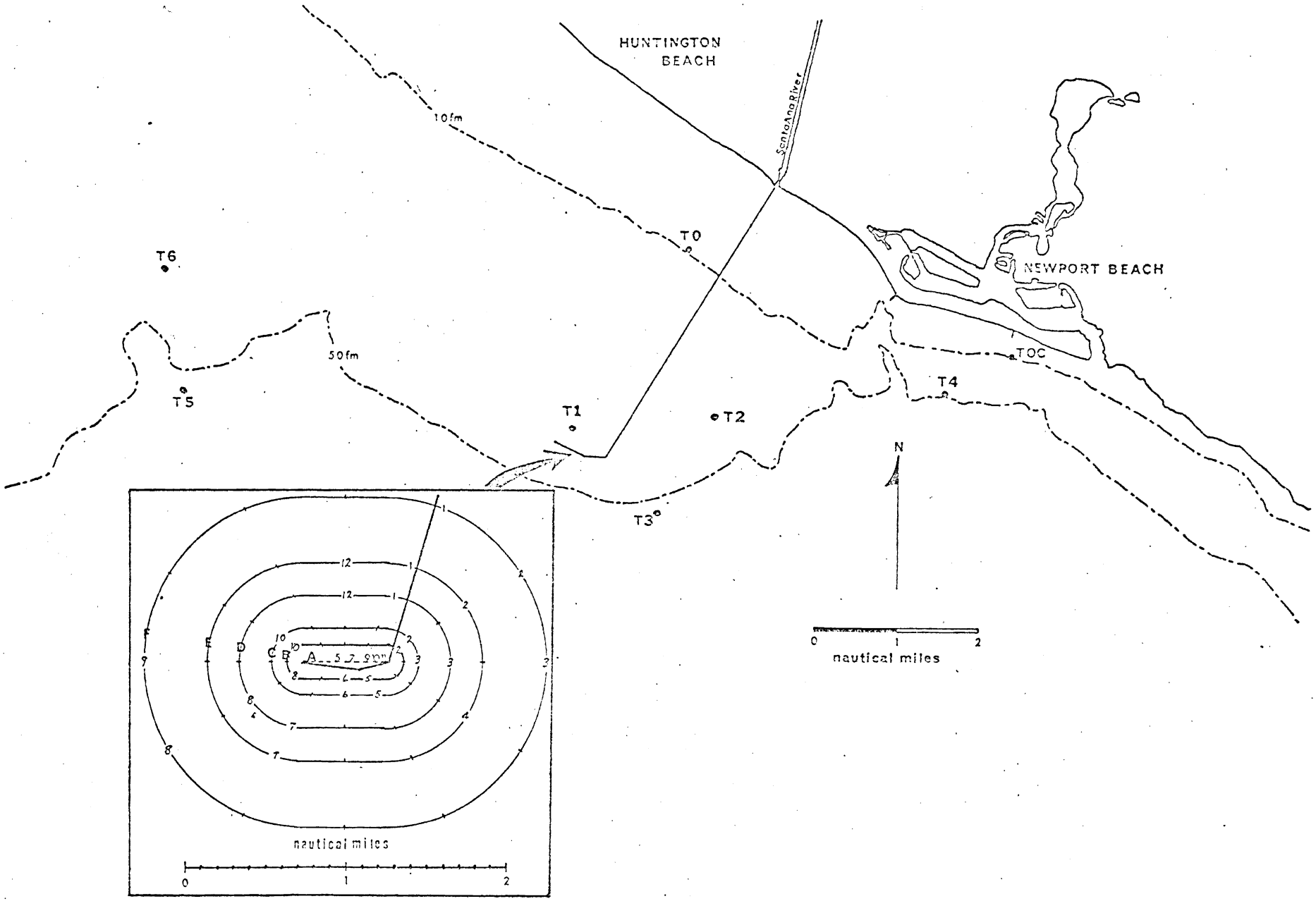
The California Department of Fish and Game and the State Water Resources Control Board (through Regional Board #8, Orange County) entered into an agreement whereby the Department conducted a subtidal ecological investigation of the marine environment in the vicinity of Orange County Sanitation District's Ocean Outfall No. 2. The objective of the study was to provide the Regional Water Quality Control Board with data to assist them in evaluating the effects of the discharge on the marine environment and in evaluating the continuous monitoring program conducted by the sanitation district.

The survey included: (i) a series of trawls made in the same station areas trawled quarterly by representatives of the sanitation district; (ii) benthic grab samples taken within one mile of the discharge site; (iii) depth profiles of temperature and dissolved oxygen levels near the discharge site and; (iv) diving stations on both discharge pipes in shallow depths. Field work was done from the Department's 28m (92 ft) research vessel KELP BASS and the 30m (100 ft) research vessel N.B. SCOFIELD.

The State Water Resources Control Board reimbursed the Department for part of the expenses incurred during this study.

Area Description

The Orange County Sanitation District's Outfall No. 2 lies approximately 6.4 km (4 miles) offshore from the mouth of the Santa Ana River between Huntington Beach and Newport Beach (Figure 1). The 305 cm (120 inch) diameter pipe terminates in a 0.8 km (0.5 mile) long diffuser section in approximately 61m (200 ft) of water. The discharge rate averages about 80 million gallons per day (MGD).


HUNTINGTON
BEACH
Santa Ana River
10fm
T0
T6
NEWPORT BEACH
50fm
T5
TOC
T4
T1
T2
T3
N
0
1
2
nautical miles
nautical miles
0
1
2

Outfall No. 1 (18m (60 ft) deep) is no longer in general use and is kept at a minimum flow to prevent sanding in and to prevent fouling by marine organisms within the pipe. It is maintained for emergency maximum flow conditions.

The substrate near the new outfall terminus primarily consists of soft sandy mud with a few hard bottom areas present as evidenced by some rock dwelling species appearing in the trawl catches.

BENTHIC TRAWL STATIONS

Methods

Eight trawl stations were occupied on June 19, 1972 ranging in depth from 15 to 146m (50 to 480 ft) (Table 1). Trawling sites and directions followed the sampling plan established by representatives of Orange County Sanitation District as part of their monitoring program.

Trawls were conducted from the N. B. SCOFIELD using a 12m (40 ft) shrimp trawl with a 3.8 cm (1½ inch) mesh body and a 1.3 cm (½ inch) mesh liner. The net was rigged with 4 aluminum floats on the headrope, 0.9m by 1.5m (3 ft by 5 ft) metal doors attached 3.7m (2 fathoms) from the wings, and a tickler chain. Trawls were 5 minutes in duration measured from the time the net touched bottom to the initiation of retrieval.

Standard length measurements of all fishes captured were made in the laboratory and all invertebrates unidentifiable in the field were brought to the laboratory for positive identification. All fishes were examined for external abnormalities (i.e., fin erosion, ambicoloration, etc.).

Results

A total of 966 fish representing 34 species was collected during trawling operations. The most abundant fishes, respectively, were half-banded rockfish, *Sebastes semicinctus*, pink seaperch, *Zalembius rosaceus*

TABLE 1. Station location, Depth Range and Course for Trawl Stations Occupied During a Survey near Orange County Sanitation District's Ocean Outfall, June 19, 1972.

Station	Location	Depth (ft) min.	Depth (ft) max.	Course deg. true
T-1	6.3 km (3.9 miles) 219°30'T from west jetty Santa Ana River	150	155	313
T-2	4.8 km (3.0 miles) 195°T from west jetty Santa Ana River	156	168	150
T-3	6.9 km (4.3 miles) 199°T from west jetty Santa Ana River	216	228	320
T-4	5.3 km (3.3 miles) 140°30'T from west jetty Santa Ana River	144	144	085
T-5	12.4 km (7.7 miles) 250°30'T from west jetty Santa Ana River	468	480	050
T-6	12.2 km (7.6 miles) 260°T from west jetty Santa Ana River	150	156	300
T-0	2.1 km (1.3 miles) 232°T from west jetty Santa Ana River	60	65	265
T-0C	Off end of Balboa Pier parallel to beach	50	100	105

Dover sole, *Microstomus pacificus*, queenfish, *Seriphus politus*, Pacific sanddab, *Citharichthys sordidus*, California tonguefish, *Symphurus atricauda*, speckled sanddab, *Citharichthys stigmaeus*, English sole, *Parophrys vetulus*, white perch, *Phanerodon furcatus*, and calico rockfish, *Sebastes dalli* (Table 2). These ten species comprise approximately 88% of the total fish catch.

Only ten species were taken at four or more stations. These most commonly collected fish comprising 78% of the catch were: Dover sole, halfbanded rockfish, pink seaperch, Pacific sanddab, English sole, California tonguefish, speckled sanddab, plainfin midshipman, *Porichthys notatus*, yellowchin sculpin, *Icelinus quadriceriatus*, and calico rockfish.

The number of fish species per station ranged from 8 (Station T-0) to 16 (Station T-4) while total numbers of fish ranged from 23 (Station T-3) to 292 (Station T-1) (Table 3). The highest density of fish was indicated in the area immediately NW of the discharge.

Fish species diversity, using the Brillouin Index,

$$H = \frac{1}{N} \log_2 \frac{N!}{N_1! \, N_2! \, . \, . \, . \, N_j!}$$

was computed for each of the trawls. An unhealthy biota would generally be characterized by a small number of species and a large number of individuals which is, in turn, reflected by a low measure of diversity. Diversity was lowest at Station T-0C and highest at Station T-3. The shallowest stations (T-0 and T-0C) had the lowest diversity indicies but diversity had no apparent relationship with proximity to the outfall terminus.

Evidence of external abnormalities was noted in 1.6% of the fishes captured (Table 4). The most commonly afflicted species was California tonguefish (11.6%). Six of the 15 afflicted fish were caught at Stations T-1, T-2, and T-3 near the discharge.

TABLE 2. Abundance and station distribution of fishes caught in trawling operations, in the vicinity of Orange County Sanitation District's ocean outfall, June 19, 1972.

Scientific and common names	Station and Abundance							
	T-0	T-0C	T-1	T-2	T-3	T-4	T-5	T-6
SYNODONTIDAE								
Synodus lucioceps - California lizardfish	1							
SCIAENIDAE								
Genyonemus lineatus - white croaker	1	8				3		
Seriphus politus - queenfish		93				5		
EMBIOTOCIDAE								
Cymatogaster aggregata - shiner perch						1		
Phanerodon furcatus - white seaperch	11	4	5					
Zalembius rosaceus - pink seaperch		24	67	54	1	31		7
SCORPAENIDAE								
Sebastes chlorostictus - greenspotted rockfish					1			
S. dalli - calico rockfish			13	2	3	1		
S. elongatus - greenstriped rockfish					1			
S. goodei - chilipepper						11	5	
S. jordani - shortbelly rockfish							1	
S. levis - cow rockfish							3	
S. miniatus - vermilion rockfish			1		1	2		
S. paucispinis - bocaccio					3			

TABLE 2. Contd.

Scientific and common names	Station and Abundance T-0	T-0C	T-1	T-2	T-3	T-4	T-5	T-6
S. rubrivinctus - flag rockfish			5		1			
S. saxicola - stripetail rockfish							4	
S. semicinctus - halfbranded rockfish		1	104	30	1	39	29	
S. sp. - unidentified juvenile						1		2
ZANIOLEPIDAE								
Zaniolepis latispinnis - longspine			4	2				2
COTTIDAE								
Chitonotus pugetensis - roughback sculpin								1
Icelinus quadriceriatus - yellowchin sculpin	1			3		2		2
AGONIDAE								
Xeneretmus triacanthus - bluespotted poacher							1	
ZOARCIDAE								
Lycodopsis pacifica - blackbelly eelpout			2			1	2	
BOTHIDAE								
Citharichthys sordidus - Pacific sanddab			5	12	1	15	2	9
C. stigmaeus - speckled sanddab	4	1		2			3	29
Hippoglossina stomata - bigmouth sole				1		1		
Paralichthys californicus - California halibut							1	

TABLE 2. Contd.

Scientific and common names	Station and Abundance T-0	T-0C	T-1	T-2	T-3	T-4	T-5	T-6
PLEURONECTIDAE								
Glyptocephalus zachirus - rex sole							8	
Lyopsetta exilis - slendar sole			1				4	
Microstomus pacificus - Dover sole		1	68	18	8	38	10	35
Parophrys vetulus - English sole	9	1	1	6		2		3
Pleuronichthys verticalis - horneyhead turbot	6							
CYNOGLOSSIDAE								
Symphurus atricauda - California tonguefish	26	1	12		1	3		
BATRACOIDIDAE								
Porichthys notatus - plainfin midshipman			4	2	1		3	4

TABLE 3. Number of Species and Individuals Caught in Trawls near Orange County Sanitation District's Ocean Outfall, June 19, 1972.

Station	T-0	T-OC	T-1	T-2	T-3	T-4	T-5	T-6
FISHES								
No. Species	8	9	14	11	12	16	14	10
No. individuals	59	134	292	132	23	156	76	94
Species diversity*	1.72	1.63	2.29	2.05	3.51	2.97	3.00	1.98
INVERTEBRATES								
No. Species	2	2	7	10	6	7	10	11
No. individuals	39	17	103	88	72	96	161	207
TOTAL								
No. species	10	11	21	21	18	23	24	21
No. individuals	98	151	395	220	95	252	237	301

* Species diversity was calculated using the Brillouin index,

TABLE 4. External Abnormalities on Fish Caught During Trawling Operations near Orange County Sanitation District's Discharge off Huntington Beach, June 19, 1972.

Species	Station	Standard length (mm)	Abnormality
Genyonemus lineatus	T-0C	200	fin erosion
Seriphus politus	T-0C	134	fin erosion
	T-4	160	fin erosion
Sebastes miniatus	T-1	180	fin erosion
Sebastes semicinctus	T-4	117	fin erosion
Zalembius rosaceus	T-2	107	deformed spine
Symphurus atricauda	T-0	165	fin erosion
		181	ambicoloration
	T-1	138	damaged eye
		138	fin erosion
	T-4	134	fin erosion
Parophrys vetulus	T-4	283	fin erosion
Pleuronichthys verticalis	T-0	154	fin erosion
Microstomus pacificus	T-1	138	fin erosion
		140	deformed spine

The catch of 768 invertebrates during trawling operations was dominated by 5 of the 25 species captured (Table 5). These 5 species made up 88% of the total.

The sand star, *Astropectin verrilli* was the only invertebrate species captured at all stations and was most abundant at Station T-4. The large catch of urchins, *Allocentrotus fragilis*, was limited to Stations T-2, T-5, and T-6.

Parastichopus sp. (a sea cucumber) was limited to the intermediate depths while the shrimp, *Eusicyonia* sp. was present in catches from all but the two shallow Stations T-0 and T-0C.

Station T-6 revealed the highest number of invertebrate species and individuals while the shallowest stations (T-0 and T-0C) had the lowest catch.

BENTHIC GRAB STATIONS

Methods

A series of 30 benthic grabs was made within 1.6 km (1 mile) of the diffuser section using a $1/20m^2$ ponar grab. The discharge line and diffuser section were located by fathometer tracings and marked by anchored buoys. At this time we discovered that the diffuser section had a slight dogleg bend.

Grab stations were established along 6 concentric strata (A through F) encircling the diffuser. Stratum A was immediately adjacent to the diffuser pipe while strata B through F were concentric ovals 0.1, 0.2, 0.4, 0.6, and 1.0 mile respectively from the diffuser (Figure 1). Thus, all points along each stratum were equadistant from the discharge.

Each stratum was equally divided into 12 stations. Stratum A was numbered from west to east, while strata B through F were numbered in a clock-wise fashion. Five stations were then chosen at random from each

TABLE 5. Most Abundant Invertebrates Captured During Trawling Operations near Orange County Sanitation District's Ocean Outfall June 19, 1972

Species	Common name	Number of individuals	Percent of total catch
Allocentratus fragilis	sea urchin	204	26.6
Astropectin verrilli	sand star	194	25.3
Eusicyonia sp.	ridge back prawn	135	17.6
Parastichopus sp.	sea cucumber	99	12.9
Petalaster foliolata	sea star	45	5.9
Total		677	88.3

stratum and sampled with the grab.

The benthic samples collected were washed through a 1.0 mm screen, and preserved in 10% formaldehyde solution prior to sorting. All sorting was performed in the laboratory under dissecting microscopes. Polychaetes and Ophiuroids were the only groups identified to species level.

Results

Stations sampled with the Ponar grab ranged in depths from 42m (138 ft) (Station F-1) to 141m (462 ft) (Station F-8), however, most were between 55m (180 ft) and 73m (240 ft) deep (Table 6).

The most common sediment type was a gray or green-brown mud with areas or streaks of black under a 1 to 2 cm surface layer of light sediment. Sample volumes varied between 1.0 and 3.5 liters.

A total of 8476 animals was collected from the 30 grab samples. Polychaete worms and pelecypod molluscs were the most numerous animals, accounting for 48 and 26% respectively of the total. A complete listing of animals taken in Ponar grab samples is presented in Appendicies B-1 through B-6.

Total numbers of animals per station ranged from 142 (Station E-1) to 540 (Station A-5). The highest numbers per station appear to be, with few exceptions, those most influenced by the waste field (Figure 2). It appears that this effect extends from the diffuser in a NW direction.

The animals most responsible for the increased density at these stations are the polychaete worms, *Tharyx* spp. and *Capitita ambiseta*. The pattern of increased density for these polychaetes extends from the diffuser area in a NW direction (Figures 3 and 4).

In situ determinations of water temperature and dissolved oxygen were made at selected stations in strata A, B, C, E, and at a control station 6.4 km (4 miles) 239^{o} true from the outfall. Measurements were made with a Martek Model DOA in situ dissolved oxygen monitor. Recorded depths over

TABLE 6. Physical data for ponar grab samples taken in the vicinity of Orange County Sanitation Districts Ocean Outfall, May 9, 10, 11, 12 and 15, 1972.

Station	Date	Depth (meters)	Volume (liters)	Description
A-5	5-10-72	62	2.0	Brown-black mud; strong H_2S odor.
A-7	5-10-72	62	2.0	Brown-black mud; H_2S odor present.
A-9	5-12-72	62	2.0	Brown mud with black streaks; 1 to 2 cm layer of light mud on tip; slight H_2S odor.
A-10	5-15-72	62	2.5	Gray-green mud with black streaks; shell fragments abundant; slight H_2S odor.
A-11	5-9-72	62	1.5	Brown-black mud; moderate H_2S odor.
B-2	5-10-72	62	2.25	Brown-black mud; H_2S odor present.
B-5	5-15-72	67	3.0	Gray-green mud with black streaks; slight H_2S odor.
B-6	5-10-72	62	1.75	Brown-black mud; H_2S odor present.
B-8	5-10-72	66	2.5	Brown-black mud; no H_2S odor.
B-10	5-15-72	58	2.25	Gray-green sandy mud; black areas present; 1-2 cm gray-brown light sediment on top; slight H_2S odor.
C-2	5-11-72	58	2.5	Dark brown mud with black streaks; top 1 cm lighter, green-brown mud; moderate H_2S odor.
C-3	5-10-72	61	1.5	Brown-black mud; no H_2S odor.
C-5	5-11-72	67	1.5	Green-brown mud; black areas present; top 1 cm lighter green-brown mud; slight H_2S odor.

TABLE 6. Contd.

Station	Date	Depth (meters)	Volume (liters)	Description
C-6	5-15-72	66	2.0	Gray-green sandy mud with black streaks; top 2 cm loose sandy mud, slight H_2S odor.
C-10	5-15-72	56	2.25	Gray-brown sandy mud with black streaks; slight H_2S odor.
D-1	5-15-72	52	3.25	Gray-brown sandy mud with black areas present; 1 to 2 cm light, brown sediment on top; moderate H_2S odor.
D-3	5-11-72	62	2.75	Green-brown mud with black streaks; 1 to 2 cm light, brown mud on top; slight H_2S odor.
D-7	5-11-72	77	2.25	Green-brown mud with black streaks; 1 to 2 cm light, brown mud on top; slight H_2S odor.
D-8	5-15-72	69	2.25	Gray-brown sandy mud with black streaks; some broken shell debris present. 2 cm layer of light sediment (brown) on top; moderate H_2S odor.
D-12	5-11-72	53	2.5	Green-brown mud with black streaks; brown, lighter layer top 1 cm; moderate H_2S odor.
E-1	5-15-72	49	1.0	Gray-brown sandy mud with black areas present; 1 to 2 cm light, brown sediment on top; moderate H_2S odor.
E-2	5-12-72	57	2.5	Gray-brown mud with black areas; 1 cm light sediment on top, light brown; very slight H_2S odor.
E-4	5-15-72	88	2.0	Gray-brown muddy sand with abundant shell debris; very little black; no H_2S odor; much less compacted sediment than other stations.

TABLE 6. Contd.

Station	Date	Depth (meters)	Volume (liters)	Description
E-7	5-12-72	101	2.5	Gray-green sandy mud; not as compacted as shallower stations; very slight H_2S odor.
E-12	5-12-72	48	2.25	Gray-brown mud with black areas; 1 cm light sediment on top, light brown; very slight H_2S odor.
F-1	5-12-72	42	3.5	Gray-brown mud with black areas; debris abundant (twigs, etc.); moderate H_2S odor.
F-2	5-12-72	55	2.5	Gray-brown sandy mud with black areas; 1 cm light sediment on top (brown); slight H_2S odor.
F-3	5-12-72	88	3.25	Gray-green sandy mud; not as compacted as shallower stations; very slight H_2S odor.
F-8	5-15-72	141	3.5	Gray-green and brown mud with few black areas; 1-2 cm light, brown sediment on top; slight H_2S odor.
F-9	5-15-72	73	2.5	Gray-brown sandy mud with very little black; no H_2S odor.

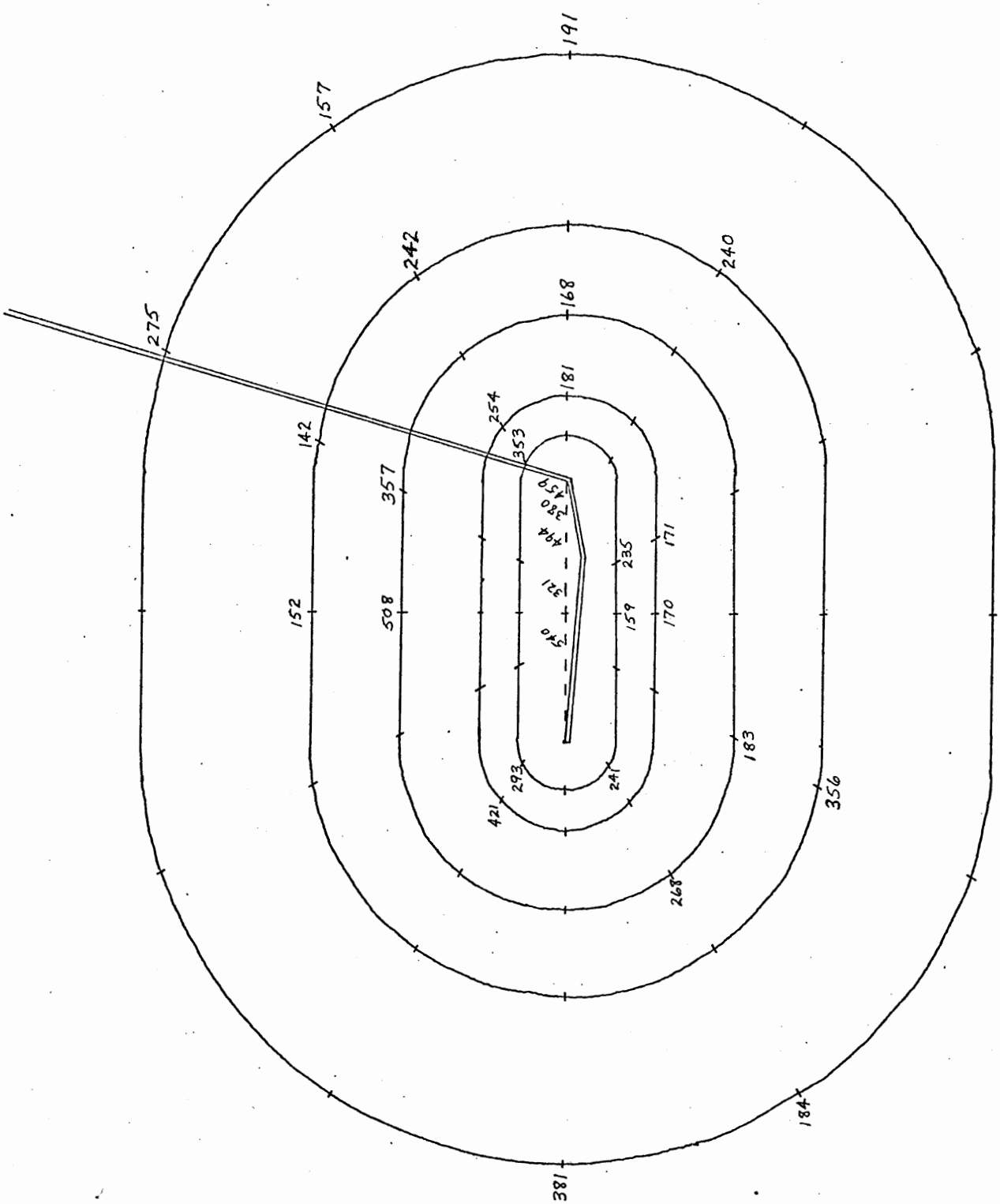


Figure 2. Total number of animals in Ponar grab samples from the vicinity of Orange County Sanitation District's Ocean Outfall

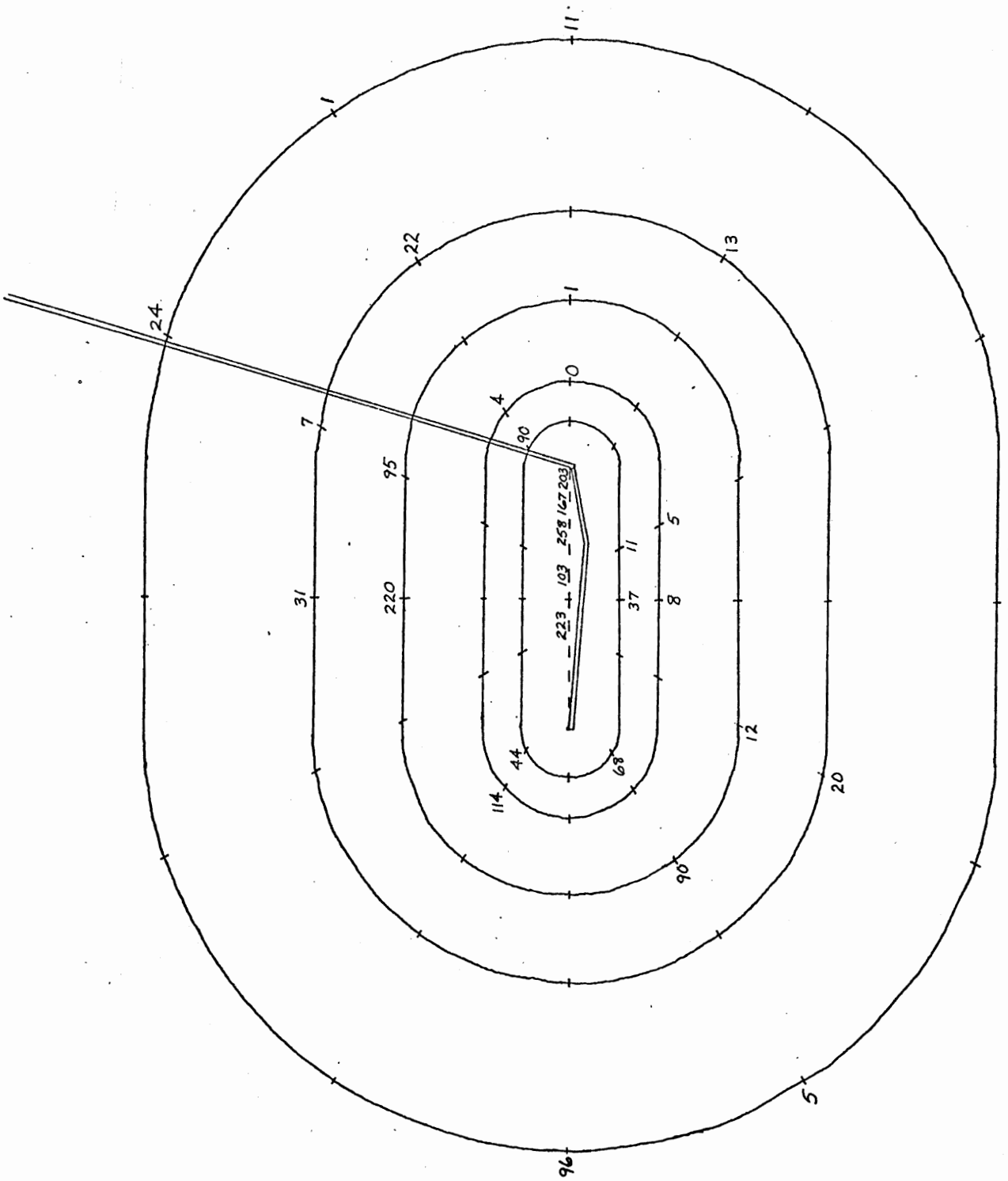


Figure 3. Number of *Tharyx* spp. in Ponar grab samples from the vicinity of Orange County Sanitation District's Ocean Outfall

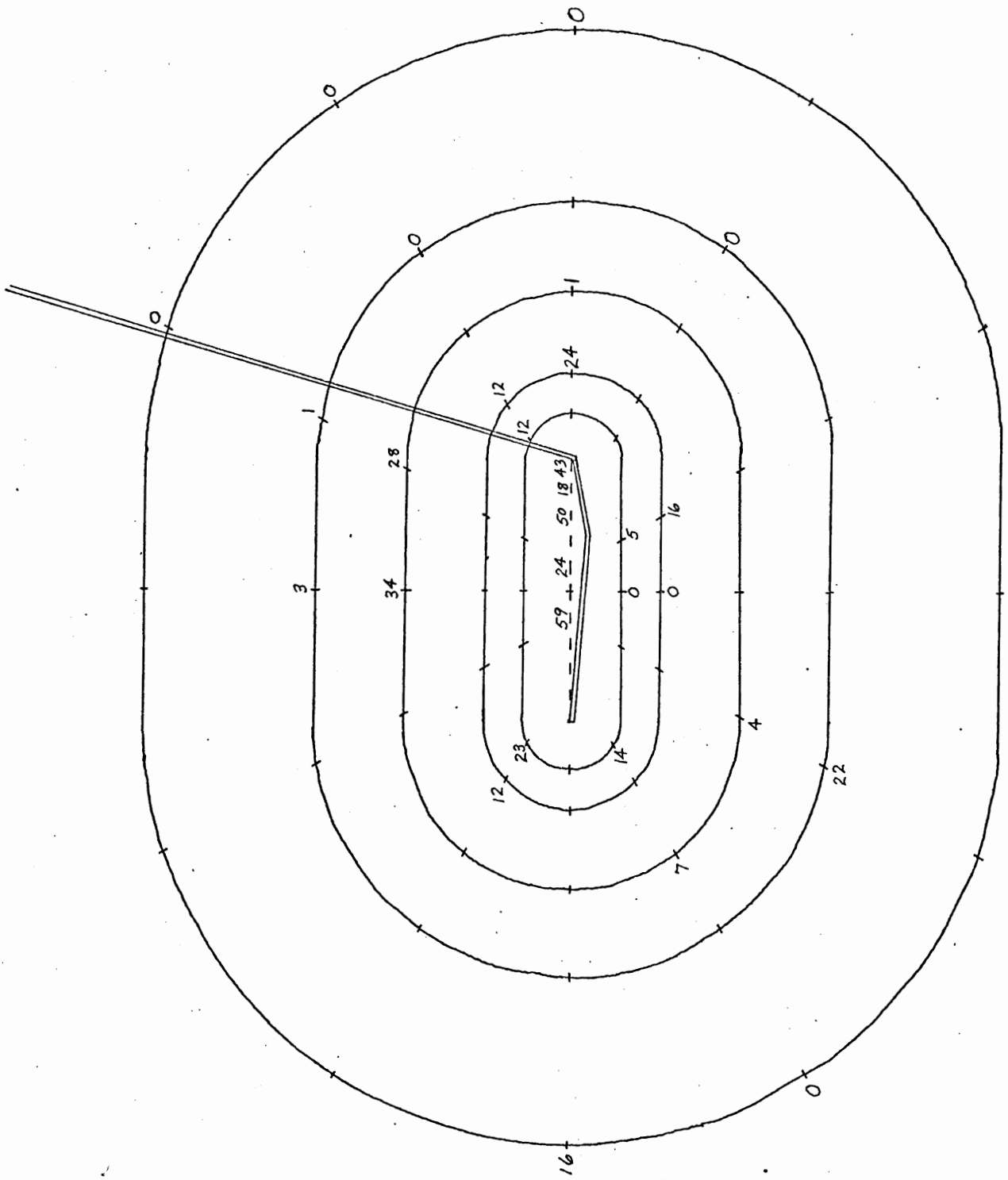


Figure 4. Number of *Capitita ambiseta* in Ponar grab samples from the vicinity of Orange County Sanitation District's Ocean Outfall

30m (100 ft) are probably slightly greater than the actual depth of the sensor due to the affects of wind and current on the cable angle.

Surface temperatures ranged from 16.2C (Stations A-6, E-12, and control) to 17.7C (Station B-3) (Table 7).

A slight thermocline was evident at 12 to 25m (40 to 80 ft) depths for most stations with a more gradual decline from 25 to 61m (80 to 200 ft). Bottom temperatures ranged from 9.4C (Station E-9) to 11.0C (Station B-3).

Dissolved oxygen levels at the surface ranged between 9.9 ppm (Stations A-11 and B-3) and 11.8 ppm (Station E-9) (Table 8). There was generally a slight increase in DO 3 to 12m (10 to 40 ft) deep and then a decline with increasing depth to minimum levels ranging from 4.2 ppm (control) to 5.8 ppm (Station B-3). Dissolved oxygen levels at stations nearest the discharge (Strata A, B, and C) were higher at 24 to 37m (80 to 120 ft) depths than stations in stratum E and the control station.

DIVING STATIONS

Methods

Diving stations to evaluate the nearshore biota were limited to the vicinity of the Santa Ana River mouth on the two discharge pipes. Four stations were surveyed on May 17 and 18, 1972 in depths of 9 to 24 m (30 to 80 ft). The main objective of the diving surveys was to record general observations of the larger invertebrate species and fish populations in the vicinity of the discharge pipes.

Sampling methods at Stations D-1 and D-3 involved only general observations of the biota present while the arc method of quantitative sampling, used in previous Department surveys (Turner, Ebert and Given, 1966), was followed to describe 30 m^2 circular plots at Stations D-2 and D-4.

TABLE 7. Temperature profiles for stations in the vicinity of Orange County Sanitation Districts Ocean Outfall

Depth (ft)	Temperature °C													
	A-1	A-6	A-11	B-3	B-9	C-3	C-6	C-9	C-12	E-3	E-6	E-9	E-12	Control
SS	17.0	16.2	16.5	17.7	17.0	17.6	17.2	17.5	17.5	16.4	16.8	16.4	16.2	16.2
10	16.4	16.2	16.2	16.9	17.0	17.3	17.1	16.7	16.8	16.1	16.0	16.0	15.7	16.1
20	16.2	16.0	16.0	16.5	16.6	16.7	16.6	16.2	16.3	15.2	15.4	15.5	15.3	16.0
30	16.0	15.5	15.8	16.2	16.2	16.1	16.2	15.9	16.0	15.0	14.9	15.3	15.0	16.0
40	15.8	14.0	15.5	16.0	15.6	16.0	15.7	15.5	15.9	13.2	13.0	15.0	14.0	15.9
50	15.2	13.5	13.8	15.9	15.0	15.8	15.2	15.0	15.6	12.8	12.6	13.5	13.0	15.4
60	14.9	13.0	13.0	15.5	14.0	15.0	14.0	14.7	15.2	12.5	12.3	12.5	12.0	14.9
70	13.2	12.5	12.5	14.9	13.7	14.7	13.8	13.7	15.0	12.0	12.0	12.0	11.4	12.8
80	12.9	12.5	12.5	13.5	13.2	14.3	13.3	13.2	14.5	11.5	11.8	11.8	11.1	11.6
90	12.7	12.0	12.0	13.1	13.0	13.0	12.5	13.0	13.8	11.0	11.4	11.0	11.0	11.0
100	12.2	12.0	12.0	13.0	13.0	12.6	12.1	12.8	13.2	10.8	11.2	11.0	10.8	10.8
120	12.0	11.5	11.5	12.7	12.4	11.9	11.8	12.3	12.4	10.5	10.5	10.3	10.2	10.3
140	11.1	11.0	10.8	12.1	12.0	11.0	11.2	12.0	11.3	10.2	10.2	10.0	10.0	10.0
160	11.0	10.5	10.5	11.7	11.2	11.0	10.5	11.6	10.9	9.9	10.0	9.8		10.0
180	10.9	10.5	10.5	11.2	10.9	10.9	10.2	10.8	10.6	9.7	10.0	9.5		9.8
200	10.7			11.0	10.4	10.3	10.1	10.4	10.4	9.5	9.7	9.4		9.6

TABLE 8. Dissolved oxygen profiles for stations near Orange County Sanitation District's Ocean Outfall

Depth (ft)	Dissolved Oxygen (ppm)													
	A-1	A-6	A-11	B-3	B-9	C-3	C-6	C-9	C-12	E-3	E-6	E-9	E-12	Control
SS	10.1	10.0	9.9	9.9	10.1	10.7	10.8	10.4	10.4	10.6	10.7	11.8	10.7	10.4
10	10.6	10.4	10.0	10.3	10.7	11.2	11.0	11.0	11.1	10.5	10.4	11.6	10.1	10.5
20	10.5	10.4	10.2	10.5	11.2	11.2	11.4	11.2	11.2	9.9	10.0	11.2	10.0	10.5
30	10.6	10.6	10.5	10.6	11.2	11.2	11.5	11.2	11.1	9.6	9.6	11.0	9.4	10.4
40	10.6	9.5	10.7	10.6	10.7	11.1	10.8	11.1	11.2	7.4	8.1	10.4	8.7	9.8
50	10.6	8.9	9.2	11.0	10.3	11.1	10.7	10.5	11.2	7.0	7.6	8.7	7.1	9.8
60	10.3	8.6	8.8	10.8	9.8	10.5	10.0	10.2	11.0	6.5	6.9	7.7	6.0	9.3
70	9.2	8.2	8.6	10.3	9.6	9.4	9.5	9.7	10.6	6.0	6.5	7.2	5.3	7.5
80	8.7	8.0	8.0	9.6	9.5	8.8	8.8	9.4	10.3	5.4	6.3	6.8	5.2	5.9
90	8.4	7.5	7.7	9.2	9.3	8.4	8.1	9.1	10.0	5.2	5.6	6.5	5.1	5.3
100	8.0	7.2	7.2	8.8	9.1	7.8	7.5	8.9	9.9	4.9	5.3	5.7	4.9	5.1
120	7.4	6.9	6.9	8.3	8.3	6.9	7.1	8.3	7.5	4.8	4.5	5.3	4.4	4.9
140	6.5	6.0	5.5	7.6	7.5	5.9	6.0	7.8	5.8	4.7	4.5	4.9	4.4	4.6
160	6.1	5.4	5.1	7.0	6.0	5.6	5.1	7.1	5.4	4.6	4.8	4.8	4.4	4.7
180	5.7	5.2	5.1	6.3	5.4	5.3	5.0	5.4	4.9	4.5	4.6	4.7		4.5
200	5.5			5.8	5.0	4.6	5.2	5.2	4.6	4.5	4.8	4.6		4.2

In addition to biological data, water temperature, dissolved oxygen, water clarity and a description of the substrate were recorded for each station area and are included as Appendix C.

Results

Station D-1 was near the terminus of the old pipe in 15m (50 ft) depth and included approximately 91m (300 ft) of the capped diffuser section. Fish were generally common at this station and the most abundant invertebrates recorded were sea stars (*Pisaster* spp.) and a low branching bryozoan *(Scrupocellaria diegensis)* (Table 9).

One gorgonian colony *(Muricea californica)* was found at Station D-1 during this survey, however, the comparable station of Marine Biological Consultants, Inc., (their station D-1) showed about 70 *Muricea* spp. colonies/m^2 in 1969 decreasing to 1/10m^2 during their November 1971 survey, (unpublished data) 3/. Their station location is slightly inshore from our location but at about the same depth.

This decrease in abundance of *Muricea* spp. since 1969, is probably a reflection of the cessation of discharge from this pipe. The large populations previously reported by Marine Biological Consultants, Inc., were probably sustained by the addition of particulate organic matter from the discharge.

Station D-2 in 11 to 12m (35 to 40 ft) depth on the new pipe, had the most diverse assemblage of both invertebrates and fish. The area on top of the pipe is a strip of mud and small riprap about 9m (30 ft) wide. Most abundant here were bryozoans *(Scrupocellaria diegensis* and *Victorella argilla)* and sea stars *(Pisaster* spp.).

Station 4 is on the new pipe directly inshore from Station 2 in 9m (30 ft) depth. The top of the pipe at 8m (25 ft) depth was covered with small riprap.

3/ Marine Biological Consultants, Inc. The marine environment off Orange County Sanitation District's ocean outfall No. 2, 1969 through 1971.

TABLE 9. Animals recorded from diving stations during a study of Orange County Sanitation Districts Ocean Outfall, May 17 and 18, 1972

Scientific name	Station and Abundance D-1	D-2	D-3	D-4	Remarks
CNIDARIA					
Muricea californica	1				
Cerianthidea			S		On mud bottom adjacent to pipe
Corynactis californica	C				Patchy distribution
Stylatula elongata			C		On mud bottom adjacent to pipe
ANNELIDA					
Diopatra ornata	C			P	In sandy areas
ARTHROPODA					
Balanus pacificus		(4)			
Balanus sp.	C	(A)	A	(S)	D-2 most empty tests, few alive
Cancer antennarius		(1)		(1)	
Cancer anthonii		(1)	2	1	
MOLLUSCA					
Anisodoris nobilis	1				
Calliostoma tricolor		(1)			
Chacea ovoidea				(S)	
Chlamys hastata		(1)			
Hinnites multirugosus		(9)			
Kelletia kelletii	S				
Megathura crenulata	S	S			
Mitrella carinata		(A)		(C)	
Pododesmus cepio	C	(1)	C		
ECHINODERMATA					
Pateria miniata	S			(2)	

TABLE 9. Contd.

Scientific name	Station and Abundance D-1	D-2	D-3	D-4	Remarks
Pisaster brevispinus	A	(34)	C	(9)	
Pisaster giganteus	S	(8)		(1)	
Pisaster ochraceous	1	(11)		(1)	
ECTOPROCTA					
Scrupocellaria diegensis	A	(A)		(C)	
Victorella argilla		(A)		(C)	
Bryozoan unid. (encrusting)	C	(S)	P	(S)	
ASCIDIACIA					
Styela montereyensis			S		
PISCES					
Citharichthys sp.				C	
Coryphopterus nicholsi	C	S	S		
Damalichthys vacca		C	C	S	
Embiotoca jacksoni	A	A		C	
Genyonemus lineatus			3		Hook and line
Girella nigricans		C			
Hypsurus caryi		S			
Medialuna californiensis		3			
Oxylebius pictus		P			
Paralabrax clathratus	C to A	C			
Paralabrax nebulifer	C			S	
Phanerodon furcatus		C		S	
Pimelometopon pulchrum	S	1			
Pleuronichthys sp.	1				
Rathbunella sp.		1			
Scorpaena gutatta	A	P	S		

TABLE 9. Contd.

Scientific name	Station and Abundance D-1	D-2	D-3	D-4	Remarks
Scorpaenichthys marmoratus	1	2			
Sebastes auriculatus		C	1	S	
Sebastes dalli			S		
Sebastes jordani			2		Hook and line catch
Sebastes miniatus			A		
Sebastes mystinus	S	S	S	S	Juveniles
Sebastes rastrelliger		1			
Sebastes semicinctus			P		
Sebastes serranoides			2		Hook and line catch

* Abundance Symbols:

P = Present in the area but relative abundance not estimated.

S = Sparse - widely scattered throughout the area but nowhere numerous.

C = Common - unevenly present throughout the area and only occasionally numerous.

A = Abundant - numerous and evenly distributed throughout the area.

() = Parentheses around the abundance symbol indicate occurrence in 30 m^2 arc areas.

A lower diversity of animals was found at this station, but, the species present were similar to those found at Stations 1 and 2.

The deepest station (Station 3) on the new pipe revealed lower numbers of invertebrates than the shallower areas and fish species normally associated with the deeper 24m (80 ft) water. Observations at this station covered about 30m (100 ft) of the length of the pipe.

Reef associated fish were present in fair numbers at all station locations as the pipes and associated riprap function as artificial reefs on the otherwise flat sand bottom.

DISCUSSION

Trawling operations during this survey did not utilize the same gear as that used by Marine Biological Consultants, Inc., for the Orange County Sanitation District, however, fish species vulnerable to the two nets are probably the same.

Species composition of our trawl catches was similar to that reported by Marine Biological Consultants, Inc., with only minor differences that could be due to seasonal occurrences of fish or to sampling error. Diversity indicies computed for our trawl catches were similar to previous surveys with the shallower stations (T-O and T-OC) yielding the lowest diversities. The station immediately NW of the discharge (T-1) that gave us our highest catch has typically been near the lowest in total numbers of fish in previous surveys. Most of the previous surveys have been done earlier in the year (February), therefore, this survey (June) could reflect a distribution of the waste field providing seasonal enrichment of the area at trawl Station T-1 during late spring.

The 1.6% level of fish with external abnormalities is comparable to levels reported previously, however, California tonguefish were most afflicted during this survey, while white croaker and Dover sole were

generally the highest during previous surveys. Occurrences of afflicted fish were not related to distance from the outfall.

Invertebrate catches at trawl stations during this survey included fewer shrimps and more echinoderms than in previous trawl surveys conducted by the Sanitation District. The change in gear could have had some affect on selectivity of invertebrates and possibly on species composition in the catches, therefore this information does not necessarily reflect a change in invertebrate populations.

Numbers of animals in ponar grab samples taken within 1.6 km (1 mile) of the diffuser indicate higher densities of animals in the area of the diffuser and in the area NW from the diffuser. The data do not allow a determination of the total extent of the enriched area, however, it appears to extend at least 1.6 km (1 mile) from the diffuser. The polychaete worms most abundant in the enriched area (*Tharyx* sp. and *Capitita ambiseta)* are probably short lived species and changes in their population densities may be rapid, allowing detection of changes in the flow direction of nutrients from the outfall during different times of the year. It appears that, of the different types of sampling done during this survey, samples of benthic organisms in the sediments gives the most direct assessment of the affects of nutrient addition from this discharge. We would recommend initiation of a benthic grab sampling program in the vicinity of the discharge site to provide continuous data on the dynamics of these populations as related to the waste discharge.

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REFERENCES

Turner, Charles H., Earl E. Ebert and Robert R. Given. 1966. The marine environment in the vicinity of the Orange County Sanitation District's Ocean Outfall. Calif. Fish and Game, 52(1):28-48.

APPENDIX A1

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-0,
June 19, 1972

Fishes

Species	Number	X S.L. (mm)	Range S.L. (mm)	Standard deviation
Synodus lucioceps	1	368	-	-
Genyonemus lineatus	1	185	-	-
Phanerodon furcatus	11	127.09	104-168	21.718
Icelinus quadriseriatus	1	53	-	-
Citharichthys stigmaeus	4	71.25	49-58	16.978
Parophrys vetulus	9	172.33	148-220	22.956
Pleuronichthys verticalis	6	162.17	135-191	18.872
Symphurus atricauda	26	163.04	133-181	11.921

Invertebrates

ECHINODERMATA	
Astropectin verrilli	33
Pisaster brevispinus	6

APPENDIX A2

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-OC
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Genyonemus lineatus	8	189.75	159-251	31.208
Seriphus politus	93	157.60	120-192	13.215
Phanerodon furcatus	4	131.25	114-156	18.464
Zalembius rosaceus	24	76.46	53-112	18.942
Sebastes semicinctus	1	125	-	-
Citharichthys stigmaeus	1	126	-	-
Microstomus pacificus	1	244	-	-
Parophrys vetulus	1	208	-	-
Symphurus atricauda	1	153	-	-

Invertebrates

ECHINODERMATA	
Astropectin verrilli	13
Petalaster foliolata	4

APPENDIX A-3

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-1
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Phanerodon furcatus	5	98.80	90-104	5.933
Zalembius rosaceous	67	101.21	79-129	10.686
Sebastes dalli	13	128.77	115-144	8.438
Sebastes miniatus	1	180	-	-
Sebastes rubrivinctus	5	117.80	97-164	27.087
Sebastes semicinctus	104	124.99	80-153	11.179
Zaniolepis latispinnis	4	141.25	125-149	10.966
Lycodopsis pacifica	2	148.50	148-149	0.707
Citharichthys sordidus	5	124.60	99-191	38.604
Lyopsetta exilis	1	178	-	-
Microstomus pacificus	68	159.26	106-275	33.003
Parophrys vetulus	1	214	-	-
Symphurus atricauda	12	150.25	125-169	12.498
Porichthys notatus	4	148.25	135-164	13.226

Invertebrates

ARTHROPODA	
Eusicyonia sp.	12
MOLLUSCA	
Pleurobranchaea californica	7
Anomia peruviana	10
ECHINODERMATA	
Asteroid unidentified	1
Astropectin verrilli	21
Petalaster foliolata	18
Parastichopus sp.	34

APPENDIX A-4

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-2
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Zalembius rosaceus	54	89.50	52-123	22.026
Sebastes dalli	2	133.00	127-139	8.485
Sebastes semicinctus	30	87.40	76-147	14.771
Zaniolepis latispinnis	2	150.50	149-152	2.121
Icelinus quadriseriatus	3	58.33	57-60	1.528
Citharichthys sordidus	12	85.58	40-118	20.469
Citharichthys stigmaeus	2	54.50	52-57	3.536
Hippoglossina stomata	1	144	-	-
Microstomus pacificus	18	198.11	140-241	27.188
Parophrys vetulus	6	211.83	150-318	55.994
Porichthys notatus	2	150.00	142-158	11.314

Invertebrates

ARTHROPODA	
Eusicyonia sp.	26
Mursia gaudichaudii	1
MOLLUSCA	
Octopus sp.	1
Pleurobranchaea californica	4
ECHINODERMATA	
Asteroid unidentified	6
Astropectin verrilli	17
Petalaster foliolata	7
Ophiura lutkenii	3
Allocentrotus fragilis	20
Parastichopus sp.	3

APPENDIX A-5

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-3
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Zalembius rosaceus	1	112	-	-
Sebastes chlorostictus	1	214	-	-
Sebastes dalli	3	133.33	129-136	3.786
Sebastes elongatus	1	213	-	-
Sebastes miniatus	1	275	-	-
Sebastes paucispinis	3	267.00	235-315	42.332
Sebastes rubrivinctus	1	114	-	-
Sebastes semicinctus	1	84	-	-
Citharichthys sordidus	1	129	-	-
Microstomus pacificus	8	204.62	142-235	31.062
Symphurus atricauda	1	162	-	-
Porichthys notatus	1	146	-	-

Invertebrates

ARTHROPODA	
Crago alaskensis	1
Eusicyonia sp.	8
ECHINODERMATA	
Parastichopus sp.	49
Astropectin verrilli	8
Petalaster foliolata	5
Pycnopodia helianthodes	1

APPENDIX A-6

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-4
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Genyonemus lineatus	3	209.00	199-217	9.165
Seriphus politus	5	167.20	145-182	15.254
Cymatogaster aggregata	1	86	-	-
Zalembius rosaceus	31	92.97	75-128	13.111
Sebastes dalli	1	120	-	-
Sebastes goodei	11	137.36	132-149	4.864
Sebastes miniatus	2	149.50	114-185	50.205
Sebastes semicinctus	39	103.26	78-143	19.567
Sebastes sp. (juv.)	1	36	-	-
Icelinus quadriseriatus	2	57.00	52-62	7.071
Lycodopsis pacifica	1	211	-	-
Citharichthys sordidus	15	106.07	87-146	15.388
Hippoglossina stomata	1	124	-	-
Microstomus pacificus	38	166.71	109-219	30.265
Parophrys vetulus	2	226.00	169-283	80.610
Symphurus atricauda	3	139.67	133-152	10.693

Invertebrates

CNIDARIA	
Muricea californica	1
ARTHROPODA	
Eusicyonia sp.	22
Podochela hemphilli	1
ECHINODERMATA	
Astropectin verrilli	54
Petalaster foliolata	10
Ophiothrix spiculata	2
Parastichopus sp.	6

APPENDIX A-7

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-5
June 19, 1972

Fishes

Species	Number	$\bar{X}$ S.L. (mm)	Range S.L. (mm)	Standard deviation
Sebastes goodei	5	133.20	129-137	2.864
Sebastes jordani	1	154	-	-
Sebastes levis	3	193.00	149-267	64.467
Sebastes saxicola	4	143.00	134-161	12.247
Sebastes semicinctus	29	98.59	43-129	29.122
Xeneretmus triacanthus	1	84	-	-
Lycodopsis pacifica	2	230.00	219-241	15.556
Citharichthys sordidus	2	99.50	98-101	2.121
Citharichthys stigmaeus	3	76.00	74-78	2.000
Paralichthys californicus	1	515	--	-
Glyptocephalus zachirus	8	145.12	113-194	33.095
Lyopsetta exilis	4	142.00	112-173	27.580
Microstomus pacifica	10	178.30	99-269	42.805
Porichthys notatus	3	139.00	131-147	8.000

Invertebrates

ARTHROPODA	
Crago communis	13
Crago resima	1
Crago sp.	3
Eusicyonia sp.	65
Spirontocaris bispinosa	9
ECHINODERMATA	
Astropectin verrilli	17
Petalaster foliolata	1
Ophiura. lutkenii	2
Ophiothrix spiculata	1
Allocentrotus fragilis	49

APPENDIX A-8

FISHES AND INVERTEBRATES CAPTURED AT TRAWL STATION T-6,
June 19, 1972

Fishes

Species	Number	X S.L. (mm)	Range S.L. (mm)	Standard deviation
Zalembius rosaceus	7	94.57.	57-130	27.055
Sebastes sp. (juv.)	2	33.50	33-34	0.707
Zaniolepis latispinnis	2	154.50	153-156	2.121
Chitonotus pugetensis	1	89	-	-
Icelinus quadriseriatus	2	47.50	47-48	0.707
Citharichthys sordidus	9			
Citharichthys stigmaeus	29			
Microstomus pacificus	35	177.77	55.232	34.633
Parophrys vetulus	3	258.33	233-209	43.879
Porichthys notatus	4	134.50	102-180	32.757

Invertebrates

ARTHROPODA	
Crago alaskensis	3
Eusicyonia sp.	2
MOLLUSCA	
Pleurobranchaea californica	1
Dorid nudibranch	1
Flabellinopsis iodinea	1
Pectin digensis	1
ECHINODERMATA	
Astropectin verrilli	31
Ophiura lutkenii	7
Ophiothrix spiculata	2
Allocentrotus fragilis	135
Parastichopus sp.	23

APPENDIX B-1

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM A

Scientific name	Station and Abundance				
	5	7	9	10	11
NEMERTEA	1		1	2	25
NEMATODA	1				7
ANNELIDA - POLYCHAETA					
Polynoidae					
Harmothoe lunulata		2			
Sigalionidae					
Pholoe glabra	3		2		1
Sthenanelanella uniformis					1
Phyllodocidae					
unidentified	2	1	1		2
Hesionidae					
unidentified					1
Nereidae					
unidentified	2				
Nephtyidae					
Nephtys cornuta franciscana	4	1		1	
Nephtys sp.		2	1		
Glyceridae					
Glycera sp.	8	4	4	5	4
Goniadidae					
Goniada brunnea	2	1	2	4	1
Goniada sp.					
Glycinde armigera			1		
Lumbrineridae					
Lumbrineris cruzensis				18	
Lumbrineris sp.	15	22	27		33
Arabellidae					
Drilonereis falcata	2				
Paraonidae					
Aricidea neosuecica	1		1	2	
Aricidea suecica	1				
Paraonis gracilis	4				

APPENDIX B-1-Continued

Scientific name	Station and Abundance				
	5	7	9	10	11
Spionidae					
Laonice sp.	1	1			
Nerinides pigmentata			1	1	
Prionospio cirrifera	3				
Prionospio malmgreni	4	5	6		3
Spiophanes missionensis		2	5		
unidentified			1		
Cirratulidae					
Tharyx spp.	223	103	258	167	203
Flabelligeridae					
Pherusa sp.	2		2	1	1
Opheliidae					
Travisia brevis	1		1		
Sternaspidae					
Sternaspis fossor	1				
Capitellidae					
Capitella capitata	6		1	5	2
Capitita ambiseta	59	24	50	18	43
Notomastus sp.				1	
unidentified	1	1			2
Maldanidae					
Rhodine bitorquata	1				
unidentified	1	1	1		1
Pectinariidae					
Pectinaria californiensis	8	5	1	4	9
Ampharetidae					
unidentified	1	1			1
Terebellidae					
unidentified			1		
Sabellidae					
Chone sp.	1	1			1
unidentified			1		

APPENDIX B-1-Continued

Scientific name	Station and Abundance				
	5	7	9	10	11
SIPUNCULIDA		4			
ARTHROPODA					
Ostracoda	23	22	18	17	13
Copepoda	1	2	7	2	1
Cumacea	9	6	2		1
Isopoda	1	4	6	1	2
Gammaridea	9	13	21	12	7
Caprellidea				1	
Euphausiacea					1
Brachyura	1		1		1
MOLLUSCA					
Gastropoda	17	4	10	17	11
Pelecypoda					
Parvalucina tenuisculpta	37	35	18	16	22
Pelecypopa (unidentified)	58	47	23	38	45
Scaphapoda		1			
ECTOPROCTA	P	P		P	
ECHINODERMATA					
Asteroidea		1	1		
Ophiuroidea					
Amphiodia digitata	1	1	1	2	1
Amphiodia urtica	7		4	18	7
Amphiodia sp.	2	1	3	9	1
Ophiuroid unidentified	3	2	5	15	4
Holothuroidea					1
CHAETOGNATHA	2				

APPENDIX B-2

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM B

Scientific name	Station and Abundance				
	2	5	6	8	10
COLENTERATA					1
NEMERTEA				6	
ANNELIDA -					
Polynoidae					
unidentified		1		1	
Polyodontidae					
Panthalis pacifica		1			
Sigalionidae					
Pholoe glabra	3	2		2	1
Pholoe sp.			3		
Sthenanelanella uniformis		1			
Phyllodocidae					
unidentified			1	1	3
Hesionidae					
unidentified		1			2
Syllidae					
Exogone sp.		1			
Nereidae					
unidentified	1				2
Nephtyidae					
Nephtys cornuta franciscana	1	1	1	2	
Nephtys sp.		1		2	
Glyceridae					
Glycera sp.	5	9	4	7	5
Goniadidae					
Goniada brunnea	5	2	3	1	1
Onuphidae					
Hyalinoecia juvenalis				1	
Lumbrineridae					
Lumbrineris cruzensis			5		
Lumbrineris sp.	20	31		13	11
Arabellidae					
Drilonereis falcata				1	
Paraonidae					
Aedicira sp.	1			1	

APPENDIX B-2-Continued

Scientific name	Station and Abundance				
	2	5	6	8	10
Aricidea neosuecica	3				1
unidentified	1				
Spionidae					
Laonice sp.	1	1	1		
Nerinides pigmentata		1		1	
Prionospio cirrifera				3	
Prionospio malmgreni	3	7	3	1	7
Prionospio pinnata	2		1	1	
Spiophanes missionensis	2	2	1		1
Cirratulidae					
Tharyx spp.	90	11	37	68	44
unidentified	1				
Flabelligeridae					
Pherusa sp.	2	1			2
Sternaspidae					
Sternaspis fossor					1
Capitellidae					
Capitella capitata	2	1		1	1
Capitita ambiseta	12	5		14	23
unidentified	4	1		1	
Maldanidae					
unidentified	2		1	1	
Pectinariidae					
Pectinaria californiensis	5	3	2	5	10
Ampharetidae					
unidentified	2	1			
Terebellidae					
unidentified	1		1		13
Trichobranchidae					
Terebellides stroemii					1
Sabellidae					
Chone sp.		2		1	
ECHIUROIDEA	3		1		
SIPUNCULOIDEA	1		2	2	
ARTHROPODA					
Ostracoda	16	45	15	19	38

APPENDIX B-2-Continued

Scientific name	Station and Abundance				
	2	5	6	8	10
Copepoda		1			
Cumacea	2	3	1	2	1
Isopoda	8	3			5
Gammaridea	10	21	4	9	5
Brachyura					1
MOLLUSCA					
Gastropoda	19	2	1	2	22
Pelecypoda					
Parvalucina tenuiscupta	36	17	17	10	16
Pelecypoda (unid.)	66	21	30	23	64
Scaphapoda	8				
ECTOPROCTA	P				P
ECHINODERMATA					
Asteroidea					
Astropectin verrilli			1		
Ophiuroidea					
Amphiodia digitata		2			
Amphiodia urtica	6	12	12	16	2
Amphiodia sp.	1	8	7	12	1
Amphiura acrystata					1
Ophiacantha sp.		1			
Ophiuroid (unid.)	7	8	1	8	6
Holothuroidea		2	2		
CHAETOGNATHA					

APPENDIX B-3

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM C

Scientific name	Station and Abundance				
	2	3	5	6	10
COELENTERATA					
Hydrozoa	P				
NEMATODA				1	
ANNELIDA - POLYCHAETA					
Polynoidae					
unidentified			1		
Sigalionidae					
Pholoe sp.	2				
Sthenanelanella uniformis		3			
Phyllodocidae					
unidentified	1				2
Syllidae					
Exogone sp.	1				
Nereidae					
Platynereis bicanaliculata	1				
unidentified		2			1
Nephtyidae					
Nephtys cornuta franciscana					1
Nephtys sp.	1		1		
Glyceridae					
Glycera sp.	6	3	3	5	5
Goniadidae					
Goniada brunnea		1		2	2
Onuphidae					
unidentified		1			
Lumbrineridae					
Lumbrineris cruzensis	13				
Lumbrineris index	1				
Lumbrineris tetraura	1				
Lumbrineris sp.		18	22	11	16
Arabellidae					
Drilonereis sp.	2				

APPENDIX B-3-Continued

Scientific name	Station and Abundance				
	2	3	5		10
Dorvilleidae					
unidentified					1
Paraonidae					
Aricidea neosuecica		2	2		
Aricidea suecica			1	2	
Paraonis gracilis					1
Spionidae					
Laonice sp.				1	1
Prionospio malmgreni	1	5	4	2	13
Prionospio pinnata			1		
Spiophanes missionensis	7		2	2	1
unidentified		1			1
Cirratulidae					
Tharyx spp.	4		5	8	114
unidentified		1	1	1	
Flabelligeridae					
Pherusa sp.	2				2
Sternaspidae					
Sternaspis fossor	1				3
Capitellidae					
Capitella capitata					3
Capitita ambiseta	12	24	16		12
unidentified	2		1	5	1
Maldanidae					
Praxillella gracilis					1
unidentified	2	2	1	4	3
Pectinariidae					
Pectinaria californiensis	8	3	5	4	11
Ampharetidae					
unidentified		3			2
Terebellidae					
Pista cristata	2				
unidentified			1		7
Sabellidae					
Chone sp.				1	1

APPENDIX B-3-Continued

Scientific name	Station and Abundance				
	2	3	5	6	10
ECHIURIDA	1		1		
SIPUNCULIDA	6	1			
ARTHROPODA					
Cirripedia	11				
Ostracoda	8	6	14	36	31
Copepoda	2	1	2		
Cumacea	4		1	1	5
Isopoda	6	1	1	3	1
Gammaridea	19	14	9	13	15
Caprellidea	5				
MOLLUSCA					
Gastropoda	1	11	10	5	30
Pelecypoda	39	49	30	37	77
Parvalucina tenuisculpta	14	23	33	21	26
Scaphapoda					2
Pteropoda		1	1		1
ECTOPROCTA		P	P	P	P
ECHINODERMATA					
Ophiuroidea					
Amphiodia digitata		1			
Amphiodia urtica	8		1	2	5
Amphiodia sp.	21			1	12
Ophiura lutkeni			1		
Ophiuroid (unid.)	25	4		1	7
Holothuroidea	1				
CHAETOGNATHA	1				

APPENDIX B-4

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM D

Scientific name	Station and Abundance				
	1	3	7	8	12
NEMATODA				1	
ANNELIDA - POLYCHAETA					
Polynoidae					
Harmothoe lunulata			1		
unidentified	1				
Sigalionidae					
Pholoe glabra	1				1
Pholoe sp.				1	
Sthenanelanella uniformis		1	3		1
Sthenelais tertiaglabra				1	
Thalenessa spinosa			1		
Phyllodocidae					
Eteone sp.					2
unidentified			1		2
Hesionidae					
unidentified					1
Syllidae					
unidentified			1		
Nereidae					
unidentified	2				4
Nephtyidae					
Nephtys cornuta franciscana			1		
Nephtys sp.		1	1		
Glyceridae					
Glycera sp.	7	3	3	3	8
Goniadidae					
Goniada brunnea	6	2	3		4
Onuphidae					
Diopatra sp.					1
Lumbrineridae					
Lumbrineris cruzensis				11	
Lumbrineris latreilli				2	
Lumbrineris tetraura				1	

APPENDIX B-4-Continued

Scientific name	Station and Abundance				
	1	3	7	8	12
Lumbrineris sp.	22	17	11	1	16
Arabellidae					
Drilonereis falcata		1			
Orbiniidae					
unidentified	1				
Paraonidae					
Aedicira sp.					2
Aricidea neosuecica					1
Aricidea sp.	1				
Paraonis gracilis	2			2	
Spionidae					
Laonice sp.	1				
Nerinides pigmentata	1				
Polydora sp.	1				
Prionospio malmgreni	4	2	1	6	6
Spiophanes missionensis	16	3			2
Cirratulidae					
Tharyx sp.	95	1	12	90	220
unidentified					3
Flabelligeridae					
Flabelligera infundibularis				1	
Pherusa sp.					2
Scalibregmidae					
Scalibregma inflatum	1	1			
Opheliidae					
Travisia brevis		1			
Sternaspidae					
Sternaspis fossor		1	1		2
Capitellidae					
Capitella capitata	2		1		2
Capitita ambiseta	28	1	4	7	34
unidentified		1			4
Maldanidae					
Asychis disparidentata					1
Rhodine bitorquata				1	

APPENDIX B-4-Continued

Scientific name	Station and Abundance				
	1	3	7	8	12
unidentified	2	1	4		3
Pectinariidae					
Pectinaria californiensis	9		5	4	1
Ampharetidae					
unidentified	3			1	1
Terebellidae					
unidentified		1			
Sabellidae					
Chone sp.					1
ECHIURIDA		3			1
SIPUNCULIDA			1		1
ARTHROPODA					
Cirripedia				11	
Ostracoda	3	2	55	14	19
Copepoda	1				4
Cumacea	3		5	2	2
Isopoda	6	1			3
Gammaridea	8	10	8	19	7
Caprellidea	1			2	
MOLLUSCA					
Gastropoda	14	15	6	1	35
Pelecypoda					
Parvalucina tenuisculpta	18	30	8	42	25
Pelecypoda (unid.)	66	48	22	36	77
Scaphapoda	2	2	1		
ECTOPROCTA	P	P		P	
ECHINODERMATA					
Ophiuroidea					
Amphichondrius sp.			1		
Amphiodia digitata			1	1	
Amphiodia urtica	11	9	17	8	8
Amphiodia sp.	3	5	4		1
Ophiura lutkeni				1	
Ophiuroid (unid.)	12	4			1
Holothuroidea	1	2			
CHAETOGNATHA	2			2	

APPENDIX B-5

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM E

Scientific name	Station and Abundance				
	1	2	4	7	12
ANNELIDA - POLYCHAETA					
Polynoidae					
Harmothoe lunulata			1		
unidentified	1			1	
Sigalionidae					
Pholoe glabra			2	2	1
Sthenanelanella uniformis	2				
Chrysopetalidae					
unidentified	1				
Phyllodocidae					
unidentified	1	1	1		
Nereidae					
unidentified	7			1	
Nephtyidae					
Nephtys cornuta franciscana				1	
Nephtys sp.			1		
Glyceridae					
Glycera sp.	4	5	4	3	5
Goniadidae					
Goniada brunnea	1		2	4	2
Onuphidae					
Diopatra sp.				1	
Eunicidae					
Eunice americana			1		
Lumbrineridae					
Lumbrineris cruzensis		8			
Lumbrineris index		1			
Lumbrineris sp.	7	15	16	8	14
Arabellidae					
Drilonereis falcata			3	1	
Drilonereis sp.		1			
Notocirrus sp.					1

APPENDIX B-5-Continued

Scientific name	Station and Abundance				
	1	2	4	7	12
Orbiniidae					
unidentified				1	1
Paraonidae					
Aedicira sp.	1	1			
Aricidea suecica					2
Paraonis gracilis					1
Spionidae					
Laonice sp.	1			2	1
Nerinides pigmentata					1
Polydora sp.	1				1
Prionospio cirrifera				1	1
Prionospio malmgreni	1	8		9	
Prionospio pinnata				1	1
Spiophanes missionensis	1	8	4	2	2
unidentified		1			
Cirratulidae					
Tharyx spp.	7	22	13	20	31
unidentified				1	
Flabelligeridae					
Pherusa sp.	3	1		7	
Sternaspidae					
Sternaspis fossor	1			1	2
Capitellidae					
Capitella capitata	1	1		1	
Capitita ambiseta	1			22	3
unidentified		9	9		
Maldanidae					
unidentified		1	2		
Sabellariidae					
Sabellaria cementarium	4				
Pectinariidae					
Pectinaria californiensis	2	7	4	12	2
Ampharetidae					
unidentified	1	1	1	1	1
Amphicteis scaphobranchiata				1	

APPENDIX B-5-Continued

Scientific name	Station and Abundance				
	1	2	4	7	12
Terebellidae					
unidentified	1				
Sabellidae					
unidentified	1				
ECHIURIDA		1	4		1
SIPUNCULIDA			3	5	1
ARTHROPODA					
Cirripedia	1				1
Ostracoda	2	2	20	143	
Copepoda				1	3
Cumacea	3		4	7	2
Isopoda	2		4		1
Gammaridea	22	16	19	11	15
MOLLUSCA					
Gastropoda		7	37	22	1
Pelecypoda					
Parvalucina tenuisculpta	2	21	7	10	9
Pelecypoda (unid.)	7	65	44	12	28
Scaphapoda		1	6	2	1
ECTOPROCTA			P		
ECHINODERMATA					
Asteroidea					1
Ophiuroidea					
Amphichondrius sp.			3		
Amphiodia urtica	11	6	18	36	7
Amphiodia sp.	16	8	4	3	8
Ophiuroid (unid.)	21	22	2	5	
Holothuroidea	1	1		1	
CHAETOGNATHA					

APPENDIX B-6

ANIMALS COLLECTED IN PONAR GRAB SAMPLES - STRATUM F

Scientific name	Station and Abundance				
	1	2	3	8	9
NEMATODA				10	
ANNELIDA - POLYCHAETA					
Polynoidae					
Halosydna latior	1				
Harmothoe lunulata				4	
unidentified	1				1
Sigalionidae					
Pholoe glabra	5		1	1	6
unidentified	1		1		
Chrysopetalidae					
unidentified	1				
Phyllodocidae					
Eteone sp.			1		
unidentified		1	1		1
Hesionidae					
unidentified			1		1
Pilargidae					
Sigambra tentaculata	1				
Syllidae					
unidentified			1		
Nereidae					
unidentified	2		1		1
Nephtyidae					
Nephtys cornuta franciscana					1
Glyceridae					
Glycera sp.	5	4	9	2	5
Goniadidae					
Goniada brunnea	4	1	7		2
Glycinde polygnatha				2	
Onuphidae					
Diopatra sp.			1		
Hyalinoecia juvenalis		1			

APPENDIX B-6-Continued

Scientific name	Station and Abundance				
	1	2	3	8	9
Lumbrineridae					
Lumbrineris tetraura				1	
Lumbrineris sp.	23	21	10	2	15
Arabellidae					
Drilonereis falcata	2	1			
Orbiniidae					
unidentified			1		2
Paraonidae					
Aedicira sp.	1				
Aricidea neosuecica		1			
Aricidea suecica	1				1
Paraonis gracilis	1			2	
Spionidae					
Laonice sp.		1		2	1
Nerinides pigmentata	1	1			
Polydora sp.	1				
Prionospio cirrifera				2	1
Prionospio malmgreni	1	4	7	1	4
Prionospio pinnata					1
Spio filicornis		1			
Spiophanes missionensis	1	9	2		
Cirratulidae					
Tharyx spp.	24	1	11	5	96
unidentified	1				
Cossuridae					
Cossura sp.	4				
Flabelligeridae					
Pherusa	1	3			
Scalibregmidae					
Scalibregma inflatum			1		
Opheliidae					
Travisia brevis			1		1
Ammotrypane aulogaster				1	
Capitellidae					
Capitita ambiseta					16

APPENDIX B-6-Continued

Scientific name	Station and Abundance				
	1	2	3	8	9
unidentified	1	5	11	8	2
Maldanidae					
Praxillella gracilis				1	
unidentified		2	1	2	1
Pectinariidae					
Pectinaria californiensis		1		4	8
Ampharetidae					
unidentified	1				
Terebellidae					
unidentified		1			1
Trichobranchidae					
Terebellides stroemii		1			
Sabellidae					
Chone sp.	1				
Eudistylia vancouveri	2				
unidentified		2			
ECHIURIDA	3		1	1	1
SIPUNCULIDA	7		1	2	5
ARTHROPODA					
Cirripedia	32				
Ostracoda	2	3	3	62	7
Copepoda	3		1		3
Cumacea	3			2	11
Isopoda	1	1			2
Gammaridea	39	8	2	6	13
Caprellidea		1			
Pycnogonida	1				
MOLLUSCS					
Gastropoda	12	3		1	25
Pelecypoda					
Parvalucina tenuisculpta	6	13	60		24
Pelecypoda (unid.)	32	45	35	8	43
Scaphapoda	1				6

APPENDIX B-6-Continued

Scientific name	Station and Abundance				
	1	2	3	8	9
ECHINODERMATA					
Ophiuroidea					
Amphiodia urtica	11	7	12		36
Amphiodia sp.	26	7	5		16
Amphiura sp.		1			
Ophiuroid (unid.)	5	5	1	50	20
Holothuroidea	1	1	1		
CHAETOGNATHA	2			2	1

APPENDIX C

Physical data for dive stations included in a survey of Orange County Sanitation Districts ocean outfall off Huntington Beach, May 1972

Station	Depth (ft)	Temperature (°C)	Oxygen (ppm)	Visibility (ft)	Bottom description
D-1	SS	16.0	10.4	6	Sand bottom of 60 ft depth, top of pipe at 50 ft. Half of pipe covered by 1 ft diameter rip rap. Not much growth on pipe or rip rap. Many broken sections of diffuser pipes in area adjacent to pipe.
	10	15.5	10.4	6	
	20	14.8	9.3	6	
	30	14.5	9.1	6	
	40	14.4	8.9	6	
	50	14.2	8.5	8	
	60	13.7	7.3	10	
D-2	SS	17.5	9.8	6	40 ft bottom depth sand and mud. Top of pipe (35 ft depth) is 30 ft wide strip of mud and small (6 inch) rip rap.
	10	17.0	10.2	6	
	20	16.8	10.1	6	
	30	16.0	8.7	6	
	40	15.0	7.8	6	
D-3	SS	16.2	10.4	6	Very dark on bottom. Mud bottom at 80 ft depth. Top of pipe at 65 ft depth covered lightly with small (2-6 inch) rocks.
	10	15.8	10.2	6	
	20	15.0	9.8	6	
	30	14.5	9.7	6	
	40	13.8	8.4	6	
	50	13.8	8.2	4	
	60	13.0	6.8	4	
	70	12.5	6.2	4	
	80	12.5	6.2	2-4	
D-4	SS	16.8	10.5	10	Bottom at 30 ft loose sand and shells. Ripple marks SE-NW with a 2 ft period and 2 inch height. Top of pipe (25 ft depth) covered with small (6 inch rip rap).
	10	16.8	10.4	10	
	20	16.5	10.3	10	
	30	16.0	9.4	2-4	